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Subject: Proton Improvement Plan

Project Quarterly Summary FY12 Q4

Report #3 Oct 18, 2012

Project Milestones

Shown in table 1 below is a list of all the level 0 through 2 milestones for PIP from the previous quarter that had a late status. As shown in the table 1 all have been completed except for WBS 1.2.1.4 which was determined to have minor benefit to PIP at this stage. Table two is a list of all the level 0 through 2 milestones for PIP for Q4 from June through end of September 2012. The fourth quarter summary has base lined 19 level 3 milestones. Five of the level 3 milestones from the base lined RLS were not completed. The main reason these were not met was due to the limited personnel available for PIP during the 2012 shutdown. The delay's impact has again been pursued vigorously with shifting of labor and recommendations for additional labor funding to be allocated to tasks with significant impact to the RLS.

Table 1 PIP Level 0,1,2 FY12 Q4 Milestones

WBS	Task	Level	Original Date	Milestone	Status
1.1.1.1	High Level RF	1	Jul-12	Select option	Done
1.2.1.7	New Cavities	2	Jul-12	Initial cavity design	Delayed by Budget
1.2.7.1	Solid State Power Amplifier	2	Jul-12	Assemble and test 10 power amplifiers	Done
1.2.7.2	Solid State Driver Module	2	Jul-12	Assemble and test driver amplifiers	Done
1.2.7.4	Solid State Installation	2	Jul-12	Upgraded all east gallery stations	Done
1.1.1.2	Linac Modulator	2	Sep-12	Options identified and screened by management	Done

The WBS 1.2.1.7 Q4 milestone has been affected by limited personnel and funds in FY12 and projected for the next few years; effectively effort for new Booster cavities has been put on hold for two years.

Table 2: PIP Level 0, 1, 2 Milestones – Follow up of FY12 3rd Quarter milestones that had a late status

WBS	Task	Level	Date	Milestone	Status
1.1.1.1	High Level RF	2	Jun-12	Determine cost and risk, preliminary RLS for all options	Completed
1.2.1.4	Cavity Test Stand	2	May-12	Assembled and Commissioned	De-scoped/Funding and Limited PIP Benefit
1.2.1.8	Cavity 1013	2	May-12	Tested	Completed
1.3	RFQ Injector	2	Apr-12	Cockcroft Walton decommissioned	Installation in Progress

The WBS 1.2.1.4 and 1.2.1.8 were initially delayed due to insufficient labor in FYQ3. However, with recent budget uploads, WBS 1.2.1.4 is now unlikely and will be de-scoped. As mentioned in the previous quarterly report, the forecasted PIP FY13 budget has been uploaded and a first pass at its impact to PIP has been completed. The updated budget profile, especially for FY13, will be discussed in the PIP budget section at the end of this report.

PIP Highlights by WBS Section

WBS 1.1 Linac

The vulnerabilities associated with the LINAC are the 200 MHz accelerating system, including power amplifier tubes and other associated systems such as the modulator; utilities for power distribution and vacuum systems; better need for reliable instrumentation along the Linac to improve beam transport and realistic machine model supported by real beam measurements. There are four largest elements of WBS Level 2 in Linac which are further subdivided at Level 3.

WBS 1.1.1 200 MHz RF Power System

The 200 MHz RF Power System represents approximately 40% of the total scope of the PIP project. There are 3 level 4 elements which will be described below.

WBS 1.1.1.1 High Level RF

In this quarter, the final report of the cost estimate and RLS for the 200 MHz multi-beam klystron (MBK) , Thales-style and 400 MHZ front end Linac options was completed and presented to Accelerator Division Head and Accelerator Associated Director in August 25, 2012. PIP management recommendation included continuing pursuing the Modulator options at a moderate rate and encouraged the R&D for a MBK system with CPI. This recommendation was fully accepted by the lab upper management. This meets a L1 milestone for this task. A final klystron specification was created and submitted to the laboratory purchase office for entering into the competitive process. Bids were solicited and awarded to the single seller who submitted a bid. The awarded seller was Communications and Power Industries (CPI). By the end of the quarter a purchase order was submitted and the team has been waiting for the final approval on the request for the procurement of a MBK.

WBS 1.1.1.2 Linac Modulator

During this quarter, the group evaluated proposals received from the Continental, SLAC and FNAL/EE support group. A modulator retreat occurred in late August. L3 manager gathered all the information and compiled on a succinct summary presented to the PIP Status Report meeting. Late September, a special meeting was held with PIP upper management who direct the course of action, therefore reaching an important L2 milestone. The decision was made to only continue with the SLAC and the in-house EE support design at this moment. The basis for the decision was cost, ability to strength multi-lab collaborations, simplicity in adapting to a change position in case the multi-beam klystron goes forward and a final decision is made to upgrade the 200 MHz HLRF to this technology.

Fermilab EE Support Department
EE support initiates the procurement of parts to build a lower voltage 10 cell prototype in house.

SLAC National Accelerator Laboratory
With the tight budget expected for FY13, the management is currently finding a way to fund building a lower voltage 2 cell modulator prototype at SLAC.

WBS 1.1.1.3 7835 Procurement

During this quarter some additional funds were allocated to purchase a new 7835. The purchase order was submitted and procurement is ongoing.

WBS 1.1.2 Accelerator Physics

WBS 1.1.2.1 Simulations and Studies

No progress was made in this task during this quarter.

WBS 1.1.2.2 *Not Used*

Some WBS numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established during the period of setting up PIP.

WBS 1.1.2.3 Linac Notch Creation

The Linac laser notch consists of six basic building blocks: 1) Optical Pulse Generator (OPG); 2) three fiber amplification stages; 3) 15 Hz burst mode controller; 4) free space amplifier system; 5) beam transport/shaping system; 6) Optical Cavity (OC). During this quarter, the laser notch team has purchased components for the OPG, first two fiber amplifier stages, and beam transport/shaping optics, and the optical cavity prototype. Some of these components were originally scheduled to happen during FY13. However, with the revised schedule developed based on the funding profile given to the PIP management for FY13, these components were purchased at the end of FY12 so that allows the team to make significant progress in building the transport/shaping optics system and the optical cavity to confirm the ability to produce the required laser beam profile inside the prototype optical cavity and that the behavior of the optical cavity is as expected during FY13 when only labor is budget for.

WBS 1.1.3 Instrumentation

WBS 1.1.3.1 Beam Position Monitors

There continues to be issues with production board assembly. The PCB error found in the 3rd quarter caused us to halt the assembly and re-do the boards. This became further complicated by issues with the PCB manufacturer. Do to personnel changes, there were problems with the initial run and they had to re-run the boards adding about a 3 week delay. All the delays had a domino effect on the assembly as well. At this time, we have received 55 fully assembled boards. This is enough to complete the Linac installation. The remaining boards are on hold as the assembly house has admitted to misplacing the parts and agreed to replace them at no cost to the lab but this will result in approximately a one month delay on delivery of the remaining boards.
Assembly and testing of the boards which have been delivered is going well. The installation locations have been prepared with new NIM bins. Work is underway to provide 805MHz reference fan-out to all modules. We are still on schedule to install all Linac modules by the start of December.

WBS 1.1.4 *Not Used*

Some WBS numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established during the period of setting up PIP.

WBS 1.1.5 Utilities

The Linac Utilities, such as power distribution and vacuum systems are composed of mostly 40 year-old equipment beyond its practical service life. There are two Level 4 elements in this WBS.

WBS 1.1.5.1 Power Distribution

L1 Substation:

During this review period, the focus was mainly devoted to the installation plan for the L1 transformer. This task proved to be extremely complicated due to the fact that the new transformer turned out to be much heavier than the original one, therefore adding challenges to the type and size of the auxiliary equipment that needs to be used in order to proceed with the installation. The plan evolved to a path where the creation of a roof hatch needed to be taking into consideration in order to lower the equipment down in to the Linac basement. In August 27, 2012, PIP project manager made a decision to not install this unit at this moment and give more required time for the group to elaborate the installation plan.

Motor Control Center (MCC):

The group is proceeding with the installation of the MCC during this shutdown. This quarter was dedicated to finalize the temporary power setup for this task with all the extra wiring of the MCC completed by the end of the report period. The installation of the unit is on schedule to happen late October.

WBS 1.1.5.2 *Not Used*

Some numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established.

WBS 1.1.5.3 Vacuum System

During this quarter, the Linac root blowers bought during 3rd quarter were delivered. Both stations were wired and tested. Both vacuum systems were moved into the tunnel but not been connected yet. The plan is to have both stations operational before the end of the Linac shutdown, which is scheduled to happen in early December 2012.

Another sub task completed this quarter is the rebuild of the Liquid Nitrogen Dewar. The Dewar was successfully rebuild and passed all the pressure vessel tests required by our ES&H department.

Finally, the 400 MeV beam valves were procured with the delivery time expected in December 2012.

WBS 1.2 Booster

Part of the PIP effort for the Booster Accelerator is to address the increase proton beam flux that will be demanded by the Fermilab program in the upcoming years. The increased flux will be achieved by providing beam on more/all of the Booster cycles; certain equipment will increase from an average 7.5 Hz to 15Hz. Overheating of old components is a major concern; several Booster PIP tasks are to upgrade/refurbish equipment to run at 15 Hz.

The aging original equipment and infrastructure of the Booster are vulnerable due to obsolescence and increase wear due to the increase of flux. Some of the PIP effort is to replace these possible reliability problems.

WBS 1.2.1 RF

WBS 1.2.1.1 Anode Supply

The design work, to be based upon the Main Injector anode supplies, will be done when manpower becomes available in FY13.

WBS 1.2.1.2 Bias Supply

Purchase orders for the heat sinks and silicon-controlled rectifiers (SCRs) have been placed. A purchase requisition has been written for water-cooled transformers and awaits the availability of funding, expect to purchase in FY14.

WBS 1.2.1.4 *Not Used*

Some WBS numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established during the period of setting up PIP.

WBS 1.2.1.4 Cavity Test Stand

The desired RF equipment from the Tevatron is not available to power the test stand. Discussions of whether other existing equipment can be used. If not, PIP management will have to discuss whether to invest in new power supplies or not build this additional cavity test stand.

WBS 1.2.1.5 Cavity and Tuners Refurbishment

The refurbishments of the second and third cavity tuner sets were done during this quarter. With each refurbishment, we are learning how to make the process go faster and reliably. The time it takes to refurbish and test each set has decreased with each set being completed; eleven weeks is the quickest time it has taken to perform a refurbishment. It appears that mating the tuners to the cavity will continue to be a crucial process on making each refurbishment successful.

WBS 1.2.1.6 New Tuners

A high power test stand for ferrite cores has been constructed and used to test old existing ferrites as well as sample ferrite cores from two potential vendors were tested. After the existing ferrite cores reproduced results similar to the original testing done 40 years ago, four sets of core samples (each vendor provided sets of ferrite core samples with either low or high permeability) were tested. Only one of the core sample sets with low permeability passed. The testing results from the three other non-usable ferrite core sample sets were sent to the vendors. With the qualified ferrite core sample set, we are constructing a tuner to be tested. A purchase order for one set ferrite cores which was validated has been done; delivery of these new cores will occur in FY13 Q2. A dialog with the two companies continues in a quest to produce ferrite cores with the high permeability. Additional material to construct several tuners has been purchased.

WBS 1.2.1.7 New Cavities

Comparison of a model developed for the current Booster RF cavities and the temperature measurements taken as part of the refurbishment task continue.

WBS 1.2.1.8 Cavity 1013

This low priority task requires the same manpower as the refurbishment task; discussions are on-going to locate manpower to complete this cavity.

WBS 1.2.2 Accelerator Physics

WBS 1.2.2.1 Simulations and Studies

Beam studies and measurements were done before the shutdown with post shutdown analysis and simulations being conducted through the rest of FY12. One of the studies was simulations of the Booster chromaticity with comparisons to actual measurements. A second analysis was also done using the Booster beam position system to measure higher mode instabilities. Work on the Booster lattice and beta function errors/corrections was in progress when the main person doing the studies and analyses left. A new person is to be named.

WBS 1.2.2.2 Alignment and Aperture

Part of the study period prior to the shutdown was devoted to a moving a magnet and re-measuring the local aperture. The increase in aperture seen is in agreement with the expected predictions. A second magnet move will be done during the start-up period at the conclusion of the shutdown.

WBS 1.2.2.3 Booster Notcher

The notcher absorber has been preassembled. From simulations it was determined that a marble shell about the absorber would be beneficial for reducing worker radiation exposure in the future; marble shielding has been purchased. The area where the absorber will be installed has been cleared and

organized before some initial shielding was installed. The re-locations of the notcher kickers and associated power system are on schedule. Procurement of parts for upgraded notcher kickers and associated power systems has started.

WBS 1.2.2.4 Booster Cogging

Based upon the current cogging equipment, initial code development for the new magnetic cogging method-system is in progress.

WBS 1.2.2.5 Booster Collimation

The collimation task is to control Booster beam loss after implementing the above notcher and cogging systems.

WBS 1.2.2.6 Radiation Shielding

There are on-going discussion and simulations of the material to be put into the Booster penetrations for shielding purposes.

WBS 1.2.3 Instrumentation

WBS 1.2.3.1 Beam Position Monitors

Design work for the Booster beam position monitor system will begin after completion of the Linac beam position monitor system.

WBS 1.2.3.2 Dampers

Studies to verify damper design choices were not done prior to the shutdown and have been postponed to the accelerator start-up period in FY13. An Initial meeting to discuss possible hardware options and labor resources will be used to layout FY13 plans.

WBS 1.2.4 *Not Used*

Some WBS numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established during the period of setting up PIP.

WBS 1.2.5 Utilities

WBS 1.2.5.1 Low Conductivity Water System

The low conductivity water system upgraded installation of new valves, gauges and pumps has been done. The refilling of the low conductivity water system has commenced which allows the identification of water leaks followed by repairs. This task will be concluded in FY13 Q1.

WBS 1.2.5.2 Power Distribution

Transformer design will be based upon recent new equipment implemented at Fermilab and will start after the Linac transformer work is done.

WBS 1.2.5.3 Vacuum System

Purchase orders for most of the vacuum equipment needed for the upgrade have been written. Purchasing will occur soon. The goal is to replace some of the aged components during the shutdown.

WBS 1.2.7 Solid State Upgrade

The Booster RF solid state upgrade has been going on piecemeal for several years with purchasing of enough components to assemble the main elements of the solid state system: power amplifier, driver module and modulator for several stations. With the Proton Improvement Plan, we have been able to buy components in quantities. Procurement is essentially complete and components for all stations are being assembled. This parallelization of the assembly processes has decreased the overall time to complete the solid state upgrade. Half of the Booster RF stations have been upgraded to the solid state components. The increased production rate has been factored into the schedule and completion of the solid state is expected to be finished in FY13 Q2.

WBS 1.3 RFQ

The FY12 Q4 RFQ effort was successful in reaching the critical milestone of decommissioning the Cockcroft-Waltons after the certification of the successful RFQ testing. The decision to proceed was given after corrections to the RFQ energy were achieved and output current reached the acceptable level criteria. The updated schedule, which reflects the removable old CW hardware and installation of the new RFQ injector, is in place.

The RFQ install has been followed closely by laboratory and PIP management. A critical task, the new injector has been given priority and the necessary labor to be completed. At the close of FY12, all M&S for the injector was completed and only install labor was required in FY13 Q1 to finish the task.

The schedule has beam commissioning starting in FY13 Q1 and available for users by the end of November 2013.

PIP Budget – Costs and Obligations Updates (FY12 Q4)

Table 3 and figure 1 below show the status of PIP budget through September 2012. It should also be noted that the requested labor does not meet the available labor.

Table 2: Summary of PIP FY12 Q4 budget – End of Year (using a burden of 1.2 for M&s and 1.96 for labor)

FY12 PIP OBL BUDGET K$	OBL BUDGET	YTD OBL	9/12 RIP	BUDGET BAL
M&S	7,161.6	5,266.8	1,458	436.8
Labor	6,640.5	6,946.2		<305.7>
FY12 Sums (End of Year)	13,802.1	12,213	1,458	131.1

Table 3: Q1 and Q2 report shown in 1st PIP quarterly report released in June 2012

FY12 PIP OBL BUDGET K$	*OBL BUDGET*	*YTD OBL*	*3/12 RIP*	*BUDGET BAL*
M&S	*7,595*	*2,044*	*298*	*5,253*
Labor	*6,884*	*3,253*		*3,631*
FY12 Sums	*14,478*	*5,297*	*298*	*8,884*

The table 3 above is given for reference purposes. It was shown in the first quarterly report and states the obligated budget in the early quarters which can be compared to the latest PIP budget summary shown in table 1. Because PIP budgets are carved out of the operating budget of Accelerator Division, fluctuations in the funding profile and labor has and will continue to require adjustments to PIP planning. In addition to M&S modifications during the FY12, labor was not part of the PIP budget process. Going forward, PIP will be required to use fully burdened labor and M&S when given budgetary guidance for RLS planning.

In September 2012 the PIP management was given a new budgetary profile. Figure 1 below shows a comparison to the PIP budget used in the original baseline and PIP design handbook to the recently given PIP budget plan. As noted above, the new funding profile uses fully burdened dollars. The difficult budgetary numbers early in the PIP timetable have had an impact on the RLS and task items. Effort to balance the needs of the PIP goals and budget guidance has been on-going and especially during FY12 Q4. The severe cut in both FY13 and FY14 PIP budget has forced delays in most PIP tasks. Priority was given to Booster RF upgrades to try and keep the 12 Hz and 15 Hz timetable. However, labor shortages may force even those tasks to have delayed completion dates. A recent updated RLS has been pushed through and is being presented at the PIP program management meeting in October 2012. Although not complete for the outlying years, a first pass at updates for FY13 and FY14 will be presented in this current RLS.

Figure 1 FY12 Q4 Budget Profile

	PIP Design Handbook	Revision August 2012
FY12	$ 17,346,668	$ 15,063,000
FY13	$ 14,779,844	$ 6,769,000
FY14	$ 19,437,625	$ 8,700,000
FY15	$ 19,873,626	$ 15,000,000
FY16	$ 14,188,092	$ 16,000,000
FY17	$ 1,113,348	$ 16,000,000
FY18	$ -	$ 11,000,000
Total	**$ 86,739,204**	**$ 88,532,000**